



**University of  
Zurich**<sup>UZH</sup>

**Zurich Open Repository and  
Archive**

University of Zurich  
University Library  
Strickhofstrasse 39  
CH-8057 Zurich  
[www.zora.uzh.ch](http://www.zora.uzh.ch)

---

Year: 2019

---

## **Guided biopsy of osseous pathologies in the jaw bone using a 3D-printed, tooth-supported drilling template**

Valdec, Silvio ; Schiefersteiner, Mona ; Rücker, Martin ; Stadlinger, Bernd

**Abstract:** Suspicious radiological findings in the jaw bone require histopathological examination for the confirmation of a diagnosis. As pathologies in this region are difficult to reach or are in close proximity to relevant anatomical structures, e.g. tooth roots or nerves, they often represent a challenge. Such factors may adversely affect the predictability of the surgical outcome of a biopsy of the osseous tissues. This technical note introduces a novel method for performing a digitally planned, guided biopsy. For this purpose, a cone beam computed tomography scan and an intraoral scan are superimposed using specific planning software. The resulting three-dimensionally printed, tooth-supported drilling template is designed for a trephine biopsy. It allows a precise, minimally invasive approach, with an exact three-dimensional determination of the biopsy location prior to surgery. The risk of devitalization of the neighbouring teeth or possible damage to the nerve structures can be minimized. Furthermore, a small access flap can be sufficient. In summary, the method of bone biopsy presented here allows high precision and greater predictability for biopsy sampling and is minimally invasive for the patient.

DOI: <https://doi.org/10.1016/j.ijom.2019.04.007>

Posted at the Zurich Open Repository and Archive, University of Zurich

ZORA URL: <https://doi.org/10.5167/uzh-182035>

Journal Article

Accepted Version



The following work is licensed under a Creative Commons: Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) License.

Originally published at:

Valdec, Silvio; Schiefersteiner, Mona; Rücker, Martin; Stadlinger, Bernd (2019). Guided biopsy of osseous pathologies in the jaw bone using a 3D-printed, tooth-supported drilling template. *International Journal of Oral and Maxillofacial Surgery*, 48(8):1028-1031.

DOI: <https://doi.org/10.1016/j.ijom.2019.04.007>

**Guided biopsy of osseous pathologies in the jaw bone using a 3D-printed, tooth-supported,  
drilling template**

Silvio Valdec<sup>1</sup>, Mona Schiefersteiner<sup>1</sup>, Martin Rücker<sup>1</sup>, Bernd Stadlinger<sup>1</sup>

<sup>1</sup> Clinic of Cranio-Maxillofacial and Oral Surgery, Center of Dental Medicine, University of  
Zurich, Zurich, Switzerland

Key words:

guided biopsy, guided surgery, digital planning, CBCT imaging, computer assisted, oral  
pathologies, 3D printing, tooth-supported template, trephine biopsy, drilling template

Correspondence:

Dr. med. dent. Silvio Valdec

Clinic of Cranio-Maxillofacial and Oral Surgery

Center of Dental Medicine, University of Zurich

Plattenstrasse 15, 8032 Zurich, Switzerland

Tel.: +41 44 634 32 90, Fax.: + 41 44 634 43 28

20    **Abstract**

21    Suspicious radiological findings in the bony jaw need a pathohistological examination for the  
22    confirmation of a diagnosis. As pathologies in this region are hard to reach or are in close  
23    proximity to relevant anatomical structures, e.g. tooth roots or nerves, they often represent a  
24    challenge. Such factors may adversely affect the predictability of the surgical outcome of a  
25    biopsy of osseous tissues.

26    This technical note introduces a novel method for performing a digitally-planned, guided  
27    biopsy. For this purpose, a superimposition of a CBCT and an intraoral scan was performed  
28    using a specific planning software programme. The resulting 3D-printed, tooth-supported  
29    drilling template is designed for a trephine biopsy. It allows a precise, minimally invasive  
30    approach, with an exact three-dimensional determination of the biopsy location prior to  
31    surgery. Risk of devitalisation of neighbouring teeth or possible damage to nerve structures  
32    can be minimised. Furthermore, a small access flap can be sufficient.

33    In summary, the presented method of a bone biopsy allows high precision and more  
34    predictability for biopsy sampling and is minimally invasive for the patient.

35

## 36    **Introduction**

37    Intraosseous lesions within the upper and lower jaw may appear cystic, lytic, sclerotic, or a  
38    mixture of these. For radiological diagnosis, a variety of imaging modalities are used. In oral  
39    and maxillofacial surgery, cone-beam computed tomography (CBCT) is commonly applied due  
40    to its high spatial resolution, accessibility, and lower radiation dosage compared to computed  
41    tomography (CT). For this reason, intraosseous lesions are common findings in CBCTs<sup>1</sup>. In  
42    radiographic images, the degree of bone remodelling around lesions will differ as to  
43    inflammatory origin, or benign and malignant lesions. These characteristics, along with factors  
44    such as location and the dimension of the lesion, allow a differentiation<sup>2</sup>. In clinics, biopsy is  
45    relevant prior to treatment. To minimise diagnostic errors, the biopsy specimen needs to  
46    include the interface between lesional and normal adjacent tissue<sup>3, 4</sup>. This technical note  
47    presents a digitally designed drill guide for biopsy sampling. Using this guide, the sampling  
48    location can be reached with increased precision and predictability.

49

## 50    **Technique**

### 51    Digital Planning

52    A three-dimensional radiography (CBCT) is uploaded into the planning software (smop,  
53    Swissmeda AG, Zürich, Switzerland) as a DICOM file. Next, a superimposition with either an  
54    intraoral surface scan or a surface scan of a cast model is performed through the upload of the  
55    corresponding STL file (Stereolithography or Surface Tessellation File). Tooth crowns are used  
56    as landmarks for facilitated matching. This results in an alignment of the 3D image and an  
57    intraoral scan. Originally, the planning software was created for guided implant surgery.

However, instead of virtually inserting a dental implant, a cylinder equivalent to the inner dimension of a trephine bur can be placed virtually into the lesion in the desired position.

The next step is the design of the tooth-supported drill guide (Fig. 1). In collaboration with the service center, the new drill guide STL-File can be exported and sent to a 3D printer. The key benefit in the 3D-printing of the drill guide is the freedom of designing a guide according to the individual surgical situation. For this reason there is no need to avoid undercuts in comparison to a milled drilling template. Additionally, enough space can be provided for water cooling and a visual overview for the surgeon can be achieved, using a skeletal design.

#### Case illustration (Fig. 1)

The teeth serve as retention for the drilling template (Fig. 2a). Surgical access depends on the location of the lesion. Based on appropriate planning, a minimal, semi-lunar mucosal incision is sufficient in most cases (Fig. 2b). Incisal edge distance and vestibular space should be considered during the planning to avoid increased tension on the buccal mucosa, possibly resulting in the elevation of the drilling template during biopsy sampling. Drilling is performed with a standard angled handpiece and a trephine bur under permanent water cooling (Fig. 2c). Subsequently a primary wound closure is performed (Fig. 2d). The biopsy specimen is transferred to the pathologist for histologic evaluation in combination with the preoperative CBCT. Possibly, a postoperative low dose CBCT, as it was performed in this case can also be supplied. A post-operative 3D-image allows the verification of the biopsy location in comparison to the preoperative planning (Fig. 3).

At the follow-up examination after 7 days, the sutures were removed. The mandible showed good wound healing and there was no sensory disturbance.

## Discussion

When applied without tension in the proper interlinking with the dentition, the application of this 3D-printed drilling template allows a reliable position for biopsy sampling<sup>5</sup>. The comparison between the virtual planning and the real patient situation was tested for this software for guided implant surgery and showed satisfying results<sup>6</sup>. These findings can be adopted for the guided biopsy technique. Additionally, using a postoperative low dose CBCT Scan, the location of the trephine drill can be radiologically analysed and serves additionally as a valuable source of information for the pathologist. Various fibro-osseous lesions of the facial bone may have a similar histo-pathological presentation and treatment options vary from a wait-and-see procedure to radical surgery<sup>1</sup>. Even with all available diagnostic tools, treatment strategies remain controversial, however. This underlines the importance of a precise biopsy specimen<sup>7</sup>.

Another advantage of the described method is the shorter duration of the surgical intervention. Especially for non- or semi-compliant patients, this can be crucial when deciding whether to perform the surgical intervention under local or general anaesthesia. Moreover, the method is also applicable for children and gives improved access to deep-seated locations in complex anatomical regions.

Another advantage is the possibility to plot the drill guide on the day of biopsy, as long as a 3D printer is available in-house. This is due to the fact that all digital steps can be performed either by the planner or the service center<sup>8</sup>.

The preoperative planning procedure reduces the time the patient is in surgery, although, compared to conventional techniques, the overall time needed for each patient remains the same. It is also important to point out that experience in planning is essential to minimise application errors<sup>5,9</sup>.

105

106 A guided biopsy with a tooth-supported drilling template is a minimally-invasive, time-effective  
107 surgical intervention, which allows more preciseness and predictability. This innovative  
108 method has its primary indication for a bone biopsy in complex anatomical regions with  
109 proximity to sensitive structures.

110

111

## References

1. MacDonald DS. Maxillofacial fibro-osseous lesions. Clin Radiol. 2015;70(1):25-36.
2. Mosier KM. Lesions of the Jaw. Semin Ultrasound CT MR. 2015;36(5):444-50.
3. Slootweg PJ, Muller H. Differential diagnosis of fibro-osseous jaw lesions. A histological investigation on 30 cases. J Craniomaxillofac Surg. 1990;18(5):210-4.
4. Mainville GN, Turgeon DP, Kauzman A. Diagnosis and management of benign fibro-osseous lesions of the jaws: a current review for the dental clinician. Oral Dis. 2017;23(4):440-50.
5. Widmann G, Stoffner R, Bale R. Errors and error management in image-guided craniomaxillofacial surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009;107(5):701-15.
6. Kernen F, Benic GI, Payer M, Schar A, Muller-Gerbl M, Filippi A, et al. Accuracy of Three-Dimensional Printed Templates for Guided Implant Placement Based on Matching a Surface Scan with CBCT. Clin Implant Dent Relat Res. 2016;18(4):762-8.
7. Li K, Yang L, Qiao YJ, Liang YJ, Wang X, Liao GQ. Risk factors and prognosis for the primary intraosseous carcinoma of the jaw. Int J Oral Maxillofac Surg. 2018.
8. Happe A, Fehmer V, Herklotz I, Nickenig HJ, Sailer I. Possibilities and limitations of computer-assisted implant planning and guided surgery in the anterior region. Int J Comput Dent. 2018;21(2):147-62.
9. Patcas R, Angst C, Kellenberger CJ, Schatzle MA, Ullrich O, Markic G. Method of visualisation influences accuracy of measurements in cone-beam computed tomography. J Craniomaxillofac Surg. 2015;43(7):1277-83.